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ABSTRACT

This paper assesses the current state of research and informed opinion on the benefits of multimedia computer software for students with disabilities. Topics include: a definition of multimedia; advantages of multimedia; Multiple Intelligence Theory which states intellectual abilities consist of seven components; motivation and behavior modification; hyperactive children; attention grabbing and distraction; technology and metacognition; the value of interactivity, immediate feedback, and hypermedia; assessment-selecting software; students as producers; teacher skills, training, and support; and technology trends. A set of interview questions for practitioners is included and the interview sample and results are discussed. Two appendices provide a profile of students with disabilities and an author biography. (Contains 39 references.) (AEF)

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The Benefits of Multimedia Computer Software for Students with Disabilities

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Introduction

The purpose of this paper is to assess the current state of research and informed opinion regarding the benefits of multimedia computer software for students with disabilities. To accomplish this task, I have undertaken a review of the research literature and conducted interviews with a number of professional educators from around the United States whom I selected based on their extensive experience with computers and students with disabilities. I have also included the results of my own experience which includes 20 years of experience with instructional software and students of all abilities in grades K through adult. (See appendix for author's biography.) I have purposely attacked this problem from as many different directions as possible. As Schwartz and Ogilvy (1980) point out, any one focus or observation is likely to give only a partial result. I have gathered multiple perspectives in an attempt to define a current consensus of opinion in this field. I also hope to provide a document that others can use to make decisions about the future use of multimedia with students of all abilities and the future direction of educational multimedia research.

Multimedia: Definition and Advantages: Multimedia software, also referred to as integrated media systems, uses a computer system to link text, sound, video, and graphics in such a way that the user's access is nonlinear and virtually instantaneous. The term hypermedia is often used to describe software that is nonlinear and where the movement from one screen to the next is relatively unconstrained. According to Hasselbring (1991), multimedia systems offer the potential to make computers more compatible with the human cognitive processes because, like the human mind, the storage format is nonlinear. The challenge for

the designer is to avoid creating a multimedia maze while the challenge for the user is to navigate the information space without getting lost.

Modern multimedia systems take advantage of high capacity storage systems such as CD-ROM's, laser videodisks, and high capacity hard disks to offer higher resolution graphics, video, and realistic human voices. Instructional programs that date back to the late 1970's, however, offer many of the same features with much less detail. Interactivity and graphics have always been prized features in instructional systems and low resolution graphic animations are effective if properly designed. The best programs from the early days have often been updated to take advantage of modern multimedia systems while programs that failed to take meaningful advantage of the technology have faded into oblivion. For these reasons, I will not restrict my focus here to modern CD-ROM products that are now starting to blossom.

Integrated media systems (IMS) are typically nonlinear allowing for movement in many directions. As a result, such environments create a major challenge by requiring the user to navigate through the information space without getting lost. This can be a problem for learning handicapped students who often have less practice with broad, goal-oriented learning tasks. It also requires the ability to create a mental map. (Hasselbring 1991) When moving through an underconstrained IMS, behavior can become entropic, goal-lost, impulsive, and distracted. For the learning disabled, overall structure can be represented by a map of the landscape, and a bookmarking system can assist in marking the user's place. Attention to this type of navigational aid can make multimedia learning environments more sensitive to the needs of all students.

Work conducted in the technology center at Vanderbuilt by Bransford and his collegues (1991) provides a wealth of data about the effectiveness of learning environments that involve situating or anchoring instruction in interesting and realistic video-based contexts that make learning more motivating, meaningful, and

useful for subsequent problem solving. Contextual cues and feedback provided by an environment allow children to make sense of their surroundings including the words they hear and use. A well designed IMS can offer many of the advantages of learning environments that occur during early childhood and apprenticeships. (Bransford 1983)

Video allows students to develop pattern recognition skills whereas text represents the output of the writer's pattern-recognition processes. Video also allows a more veridical representation of events than text. It is dynamic, visual, and spatial and, therefore, enables students more easily to form rich mental models of problem situations. This is particularly important for students who are low-achieving and for students with low knowledge in the domain of interest. (Hasselbring 1991)

Other recent studies on the use of computer programs for teaching sight words to learning disabled students by Torgeson (1986 and 1988) show significant gains in speed and accuracy. These studies support the notion that the addition of media elements such as graphic displays and digitized voice have a real impact on learning efficiency. Koskinen (1993) also supports the notion that multisensory processing (audio/video/text) enhances learning.

Multiple Intelligence Theory: During the last two years I have worked closely with the classified students in my school who represent 17% of the school's population. (See appendix A for a current national profile of students with disabilities.) I have been struck by the fact that many of them appear to have at least normal intelligence if not above normal intelligence in some areas. This has also been pointed out by teachers and verified by my research and interviews. If you subscribe to Gardner's Multiple Intelligence Theory (1993), each person's intellectual abilities are composed of seven components as opposed to the one-dimensional approach taken by the standard IQ test. I think of Gardner's seven

intelligences as the big two and the little five. The big two are linguistic and logical mathematical. These are the two that schools focus on and anyone who falls short in either is considered to be a candidate for remediation or special education services. This is the case for the vast majority of classified students in America today. The little five intelligences are spatial, musical, bodily-kinesthetic, interpersonal and intrapersonal. These are the areas where we often see classified students do well. For this reason, I included a question in my survey that asked respondents if they had noticed hidden intelligence in classified students as they worked with computer software.

For multimedia systems, spatial, also known as visual-spatial, intelligence is perhaps more important than any other. As dyslexic learners often use this intelligence to compensate for their reading difficulties, one would expect many students classified as learning disabled to do well when faced with modern multimedia learning materials. According to West (1992), the trend towards a more visually based learning program offers advantages to dyslexics who have traditionally suffered in text oriented educational systems. Developments in this field make it possible for everyone to routinely use visually-oriented methods and approaches. Prior to the advent of multimedia, only a small number of extremely gifted people could apply these methods through their own mental models.

Motivation and Behavior Modification: The assumption that people are self-motivated is supported by motivation theory and research. This assumption is also consistent with the reports of teachers that the intrinsic rewards of teaching such as reaching a child, seeing growth and development, fostering learning are most significant to them. Self-motivation is also characteristic of young people. Theory and research about motivation and personality by Clark and Astuto (1994) have demonstrated time and again that people are inherently and naturally drawn to learning, work, and responsibility.

During my interviews, the concept of motivation was almost always one of the first things mentioned. Even in the rare case where I had to ask directly about how students were motivated by access to computers, I discovered that every observer found that students motivation to engage in learning was enhanced by access to computer systems. This does not mean that every student is highly motivated by software. It means that a significant number of students in all schools studied were more motivated to learn when computers were a daily part of their learning environment. When motivation is so great, teachers have the opportunity to use the computer as part of a behavior modification plan. During my interviews I found that this was also consistently mentioned. While students are seldom denied computer time altogether due to bad behavior, they can often earn additional computer time if they follow their behavior contract.

Hyperactive Children: Hyperactive children seldom give learning tasks their sustained attention. Surprisingly, many will play video games for hours on end, to the chagrin of their parents and teachers. Margolis (1990), Director of the Motivation Center in Stratford Connecticut, suggests that the reasons why they do so are that they receive instant gratification, including very frequent visual and auditory reinforcement. They like the short bursts of action and the extraordinary excitement. They enjoy the barrage of attention-grabbing stimuli. They persist at the games, practicing, improving, and feeling rewarded, until they have a sense of acquired competence, rare indeed for them. A key feature of computer systems that makes this possible is the computer's inexhaustible patience and enthusiasm. (Olson 1990) They also thrive on the immediate feedback and attention that they receive as they interact with the computer. This aspect was one that educators found most attractive when computers first became available for use in schools. The use of immediate feedback following an action by a child has been shown by Hosler and Fadely (1989) to reinforce learning and to motivate further learning.

Attention Grabbing and Distraction: According to Krout (1990), with learning disabled and behaviorally handicapped students you have about 30 seconds before the student decides whether or not a program is "cool". While Halacz (1987) finds that for students who are easily distracted, the same media elements that can attract a student's interest, however, can also distract students from their goal. Horton (1989) notes that this problem is exacerbated by the use of two-screen systems where one screen presents text and graphics while the other screen is used for video. Horton also supports the notion that a computer program can enhance student performance over the use of textbooks and note taking.

Technology and Metacognition: Computer technology also shows promise for the implementation of cognitive and metacognitive strategy instruction. Hofmeister (1990) studied reading-delayed junior and senior high school students who were successful in meeting student learning objectives that dealt with procedures required for the use of skimming, summarizing, and note taking strategies. Carrasquillo and Nunez (1988) also found that computer-assisted instruction has potential for teaching metacognitive strategies while Salomon, Globerson, & Guterman (1989) took the next step and found gains when the software itself provided prompts to use metacognitive strategies during reading. Their program prompted students to generate inferences from titles, identify key sentences, generate imagery, and formulate summaries.

The Value of Interactivity, Immediate Feedback, and Hypermedia: Van Daal and van der Leij (1992) found that students who copied words from a screen by typing them on the keyboard made fewer spelling errors and read faster than students who wrote the words from memory and students who just read the word from the computer screen. The power of immediate feedback for the learner is also

well documented by Farmer (1992), Jones (1987) and Olson (1990). Another powerful technology, hypermedia, is recommended by Higgins and Boone (1991) as a basal reader supplement to provide a flexible format that gives the reader instant access to related information. MacArthur and Hayes (1995) have demonstrated additional success with a hypermedia model known as SALT (Student Assistant for Learning from Text). With SALT one can develop hypermedia versions of textbooks that provide a variety of reading comprehension supports. The supports include speech synthesis that allows students to have any portion of the text read to them along with a glossary, main ideas in red, a question window with questions for students to focus on as they read, and additional teacher explanations that summarize important ideas. These supports and other SALT features provide 1) compensatory support for decoding, word recognition, and vocabulary 2) cognitive and metacognitive reading strategies such as summarization, mental imagery, self-questionings, question answering, and previewing to activate prior knowledge and 3) content support. Reinking (1993), however, is concerned that the use of powerful technologies could create a level of dependence that would make the transition to traditional print media difficult.

Assessment-Selecting Software: Matching computers to individual's needs is more difficult than it seems and has been neglected. (Hawkridge and Vincent (1992 p. 28) A good example for this is found in IBM's popular Writing to Read program that teaches 1st grade students to read by learning a set of phonemes and then writing with invented spelling anything that they can say. As Slater (1991) points out, for pupils with severe learning difficulties, phonic analysis of words is beyond them. The essence of good assessment of individuals is to identify strengths as well as weaknesses. (Hawkridge and Vincent 1992 p. 194) Teacher training that focuses on deficits is inadequate in this field. (Hawkridge and Vincent 1992 p. 220)

When faced with disabled students, it is clear that software must be carefully matched to the students' interests, abilities, and current developmental stage. Majsterek and Wilson (1989) provide suggestions for how to match software to students' IEPs. All advice from the research, my interviews, and my experience reinforces Meyer and Pisha (1994) who clarified the limitations of print and the advantages of electronic multimedia to teach children to read and to teach content.

If you are not sure which programs will be more effective with your students, just take your best guess and allow the students to try it out. By observing your students in action and listening to their opinions, you will be better able to match software to individual needs.

Students as Producers: Modern technology makes it possible for young students to generate their own integrated media productions. When students become producers of their own knowledge rather than consumers, there is a powerful learning effect. In addition, the feeling of pride in one's productions is powerful and can be especially important for learning handicapped students, who traditionally have experienced difficulty in school. This phenonmena is common to the research (Hasselbring, p. 34), my interviews, and my own experience. The best example of this that I have seen is a CD-ROM that contains video portfolios of 25 students at Bell High School in Los Angeles, California. (Reilly 1993)

Teacher skills, training, and support: Much of the research in this field mentions the issues of teacher preparation and support. Cicchelli and Baecher (1989) found that inservice activities that match teachers' concern areas may reduce resistance to implementation. As Darrow (1993) claims, the most powerful way to convince teachers that multimedia systems are effective is to create multimedia tutorials for teacher training. The world of business is increasingly turning to multimedia training to update employee skills, and my own personal experience has

convinced me that learning in a well designed multimedia environment is far more effective than working with simple text based systems. Examples of the multimedia systems that have lead me to this conclusion are ABC Interactive's *In The Holy Land*, Apple Computer's *Visual Almanac*, and IBM's *Illustrated Books and Manuscripts*.

Teachers can also learn more about this subject by turning students lose and learning from the students. Everyone who responded to my survey argeed with this point, and the general finding was that students also feel empowered when the realize that they are teaching the teacher. As Green (1985) points out, learning from students can even allow educators to develop skills that facilitate career moves that would otherwise not be possible.

Technology Trends: A 1992 paper by Ray Ashton of the PolyMedia Communications Corporation cited market forecasts that predicted that over five million CD-ROM drives would be installed by 1995. While this sounded like a large number at the time, according to NewMedia Magazine, the actual number of CD-ROM drives sold during 1994 alone was 15 million and the installed base by the beginning of 1995 was 26 million.

Key trends for the year 2000 according to Ashton (1992) include improved data compression and storage technology and the increasing importance of product content. The importance of content is echoed by Hasselbring: "The best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition." Although the use of multiple representations of information in various formats have been found to improve retention and retrieval, it is important that practitioners move beyond the notion that if they use multimedia it must be good.

Questions for practitioners

After my review of the research, I developed the following set of questions to use as part of my interview process. Whenever possible, I simply engaged each person in a conversation about their experience with computers and classified students in the hope that they would touch on the points as we talked. This allowed me to see which areas they were most enthusiastic about and avoided leading them to agree with the tentative conclusions that my experience and review of the research had allowed me to reach. If any conversation failed to touch on one or more of the topics in these questions, I then resorted to asking about each missed topic.

1) What training and experience do you have?

2) Discuss the concept of motivation as it applies to your students' use of multimedia software?

3) Do you use access to computers as part of your behavior modification program?

4) How have you used software to assist students with cognitive and metacognitive strategies?

5) Have you noticed that classified students demonstrate unsuspected capabilities (intelligence) when using multimedia software?

6) Do you use computer software to assist with the delivery of your students' individual education plans and do you specifiy computer use in IEP's?

7) Do you find that you often learn more about computer use when you allow your students to experiment and show you what they discover?

8) Does success with software appear to improve self-esteem for some students?

9) What are the attributes of multimedia software that make it effective as a learning tool?

10) What are some specific titles that you would recommend to other special education teachers?

The Interview Sample: My goal for this study was to interview as many experienced special educators as possible who have used computers with their students for several years. I started with a canvass of the local school districts where I knew district level administrators who could recommend teachers to interview. As the Southern Tier of New York State is on the leading edge of computer use in education, this proved to be a rich resource. I expanded my sample by contacting friends in other parts of the United States. This included people whom I have met as a result of my experience with the Internet during the last few years. At this time my sample includes ten local educators and eight from other parts of the United States. While this may seem like a small sample for quantitative work, the extent to which the people interviewed agreed with each other makes the results meaningful.

Interview Results

1 - Experience: Everyone had at least five years of experience with special education students. The median was 10 years and the maximum was 25 years. The minimum amount of experience with computers was two years. The median was four years and the maximum was 15 years.

2 - Motivation: Everyone indicated that many of their students were highly motivated. Responses were enthusiastic and this was usually the first thing mentioned in the open-ended part of the interviews. Statements like "kids left the Christmas party to work on the computer" indicate the strength of the motivation.

3 - Behavior Modification: Half of my sample used extra computer time as part of formal behavior modification plans. No one indicated that they denied computer time as punishment if it was a planned part of their program. There was a consensus that just having computers and engaging software reduced behavior problems over all.

4 - Cognitive and Metacognitive strategies: Everyone used computers for cognitive work while only half of the sample used them for metacognitive strategies. The people who had not yet used systems for metacognitive strategies all indicated that it sounded like a good idea and that they would like to try it.

5 - Unsuspected Intelligences: The people who were familiar with multiple intelligence theory were not surprised as they had already discovered which students were strong in visual-spatial skills. Those who were not familiar with this theory (11 of 18) were surprised on occasion by unexpected abilities of classified students.

6 - Help with IEP's: Everyone used computers to deliver portions of their student's IEP's. No one indicated that there was any specific mention of computers in the IEP documents at this time. The general explanation for this fact focused on cost.

7 - Learning from students: Everyone felt that they learned a lot from their students. Statements like "enthusiasm exhibited by kids is contagious" and "it motivates me to learn more" indicate the general feeling of my sample.

8 - Self Esteem: Everyone saw improvements in self esteem with their students. The statement that "software gave them the opportunity for success which is what builds self esteem" is representative of the responses. One respondent also found that students felt like they were being valued when they were allowed to use computers.

9 - Effective Attributes: The most frequent attribute mentioned was the visual nature of the medium. Comments also focused on the multisensory attributes and that students can see words and hear them spoken at the same time. Interactivity and instant reinforcement where mentioned by most people as well. The fact that software appears to be consistent and patient is attractive to students. Several people were also concerned about the effectiveness of software design and felt that they needed more time and help from their students to properly determine the best software to use for a given objective. One topic that came up during most interviews

was the value of the simple word processor. The fact that it allowed all students to create perfectly formed characters and made for easy editing has appeal for most students.

10 - Popular Software: Software from Broderbund (Living Books, Kid Pix, Kid Works, Carmen SanDiego series), EdMark (Thinkin' Things, Kid Desk), Sunburst (The Factory), and MECC (Oregon Trail) were mentioned by at least five respondents.

Author's experience and conclusions

I did not want to have my own biases affect this work until after I completed the literature research and interviews. To this end, I based my interview questions on my review of the literature and not my own experience. I avoided leading questions as much as possible so that the interviews would not be affected by the research findings. At the end of my interviews I found that everything that I had discovered and discussed was consistent with my own experience which further supports my findings. Based on all of my work, I offer the following conclusions. While you may not find them surprising, I feel that they help support to a more rigorous degree beliefs that are commonly held by practitioners.

1) Classified students are usually highly motivated to engage in learning that involves multimedia computer systems.

2) Assess to computers can be used as an effective part of a behavior modification plan for many classified students.

3) Properly designed software can assist classified students with cognitive and metacognitive strategies.

4) Classified students often demonstrate undetected intelligences and skills when allowed to work with multimedia computer systems.

5) Access to multimedia systems can assist teachers as they implement a student's individual education plan (IEP).

6) Classified students can often learn how to use multimedia systems with little or no instruction and then demonstrate the system to teachers and other students.

7) Use of multimedia systems often improves the self-esteem of classified students.

8) The multisensory nature of multimedia software promotes effectiveness when it is used as a learning tool.

9) Motion and interactivity allow multimedia software to hold the attention of students.

10) The fact that software appears to be consistent and patient is attractive to students.

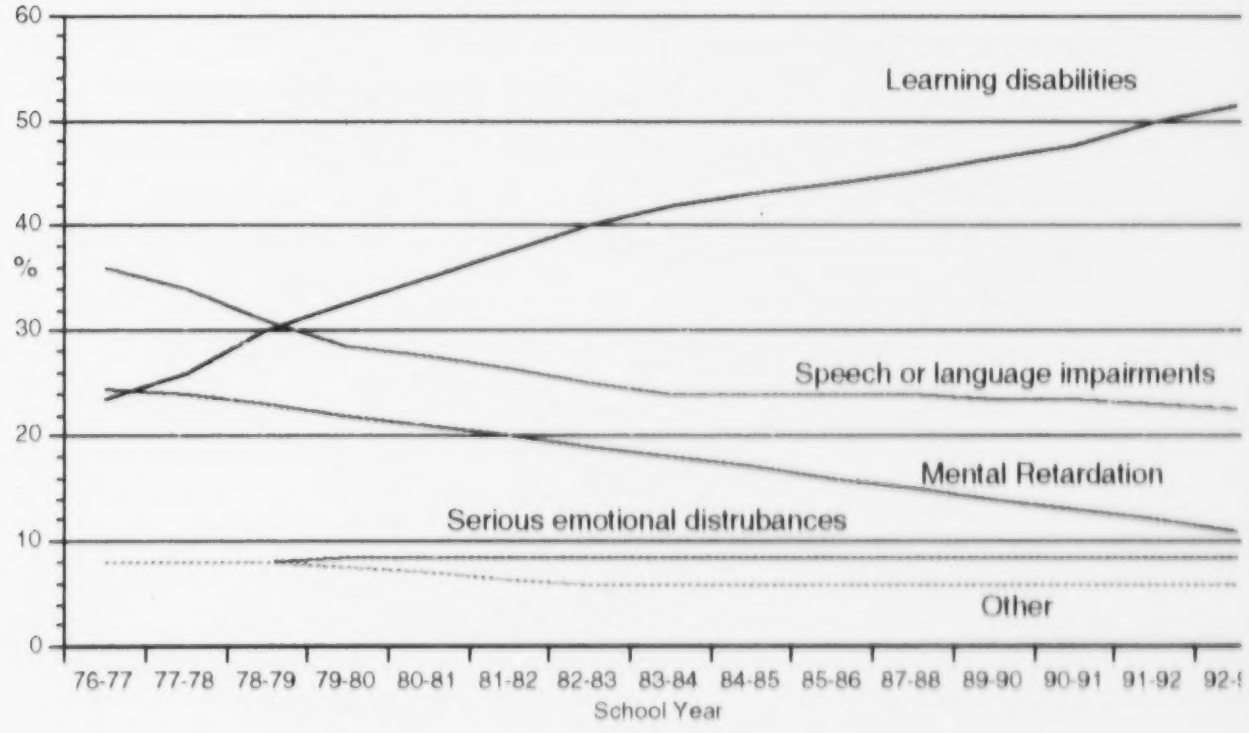
Appendix - A

Profile of students with disabilities

Roush (1995) states that as of the 1992-93 school year, the following profile of disabilities existed in American schools:

Learning disabilities	51.5%
Speech or language impairment	22.5%
Mental retardation	11.0%
Serious emotional disturbances	8.5%
Others	6.0%

A look at the trend lines in the graph below shows that since 1976, the fraction of students classified as learning disabled has increased from 24% to 51.5% which means that it has more than doubled! A closer look on a state by state basis also reveals that the number of classified students varied widely from one region tc another. In the case of learning disabilities, classifications range from 2.73% of the population in Georgia to 9.42% in Massachusetts. Recent research indicates that the cause is related to activity in the thalamus and that it may have a genetic component. This same research indicates that up to 20% of the population may suffer from some sort of learning disabilities which should cause school systems to rethink the way they deliver reading instruction to all students.



Appendix - B

Author's Biography

Since September 1993, I have been the principal of Woodrow Wilson elementary school in Binghamton, NY. Prior to that I spent 12 years as Director of Computer Services and Director of Instruction for Binghamton City Schools. My prior experience involved teaching chemistry, physics, and general science for grades 8-12 and functioning as K-12 science and computer chair for Cortland City Schools in Cortland, NY.

In 1975, I developed and taught courses in programming in BASIC at Cortland High School. At that time I also started writing for various computer publications. My first software review for a program called Visicalc, the original spreadsheet, was published in November of 1979 in Creative Computing. Since then I have published over 300 articles (mostly coauthored with my wife Denise T. Green) and reviews in journals such as InfoWorld (former contributing editor), Administrative Computing, Publish, A+, Creative Computing, MacUser, and NewMedia.

In September of 1992, I started work on a doctorate in Educational Theory and Practice at Binghamton University in Binghamton NY. During my studies I have explored teacher use of media, educators and the copyright law, issues of race, class, and gender as they apply to computer software, and various issues involving math and science education. This paper represents my most recent research in the field. I am grateful for the help I have received from my colleagues around the nation and encourage anyone with an interest in this field to contact me. I am also grateful for the patience and assistance of my wife Denise and daughter Lena who make this work possible and meaningful.

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